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System perspective in material flow analysis for LCA studies

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Introduction

Although synthetic polymer materials (i.e., plastics) have been used for relatively short time, they are produced in large volumes and used in many industrial sectors. Hence, the interest in maintaining the material value of plastics in the society. However, there is a lack of comprehensive understanding of plastic flows. Material flow analysis (MFA) accounts for flows of materials within a defined system boundary. Performing a MFA, one maps material inputs, outputs and stocks for a selected material. Such mapping is essential when performing a life cycle assessment (LCA) of waste management systems and processes.

The objective of this work is to illustrate a system perspective when performing MFA on the example of plastics in Europe.

Material and Methods

Flows of plastics in the European Union (EU) were estimated for a variety of polymers used in selected industrial sectors. An example of polypropylene (PP) is presented here. Both pre-consumer and post-consumer plastic waste was considered when quantifying flows of plastics in different waste management alternatives. Most of the data comes from industry or trade statistics and reports, supplemented by scientific publications and a range of necessary assumptions. Data presented here represent preliminary results of an ongoing research.

Results and Discussion

While substantial share of PP is used in packaging, non-packaging applications (e.g., automotive) represent considerable share of PP use in Europe. After being used, more than 5,000,000 tonnes of PP waste is generated. Approximately 40% is collected for recycling, while the remaining share of the waste is either incinerated or landfilled. Collection of the waste PP for recycling ranges from less than 20% to more than 50% for miscellaneous applications (e.g., houseware, sports) and building and construction, respectively. Almost 20% of the collected PP is exported for management outside of the EU. The majority of PP being recovered for recycling results from packaging (more than 70%), since most of the collected waste plastics are from packaging applications, where the life span of products is relatively short. This in practice means that setting higher targets for recycling only of packaging waste (containing a variety of polymers, including PP), may retain more material in the society, but will not be sufficient to achieve fully circular material flows. Less than 20% of PP consumed in the EU comes from recycled plastics (assuming no imports of recycled PP). To optimize environmental performance of the waste plastic management system LCA can be used to prioritize collection and recycling of the waste PP from different applications. However, the results of a potential LCA study will largely depend on the type and amount of a displaced material, where quality of the secondary plastics (related to presence of contaminants and degradation of the polymer itself) may play a major role.